

Multipole electric motor and process for its production

## Description

ins91

5 The invention relates to a multipole electric motor with a rotor and a stator, comprising a plurality of coils and stator laminations which are magnetically separated from one another and respectively extend from the coils to the rotor, and to a process for its  
10 production.

Multipole electric motors with a plurality of stator laminations and with two or more coils as the stator and with a cylindrical permanent magnet formed as the rotor, which has at least two magnetic poles,  
15 are known from practice. In the case of these electric motors, a stator lamination is respectively disposed from each end of the coil to the rotor, where it is situated a very small distance away from the permanent magnet. In the production of the known electric  
20 motors, the stator laminations are individually fastened to the ends of the coil and the coils are subsequently fitted in the housing of the electric motor. In the case of these known electric motors, it is disadvantageous that, to produce electric motors with  
25 identical electrical and mechanical properties, the positioning of the stator laminations with respect to the rotor is very laborious. If the stator laminations are at the wrong distance from one another or from the rotor, in the worst case the rotor may lock and the  
30 electric motor may fail as a consequence.

ins92 The invention therefore has the object of specifying a multipole electric motor in which the stator laminations are positioned particularly precisely with respect to the permanent magnet and  
35 which can be produced in a simple manner and the object of specifying a process for its production.

These objects are achieved on the one hand in the case of an electric motor according to the invention by the stator laminations being connected in

00868606-091701

09868606-091701

a region facing the rotor to a holder of non-magnetic metal. This allows them to be positioned easily with respect to one another. It is advantageous in this case that the positioning by the holder is also permanent. In the case of the production process according to the invention, the stator laminations of a motor, connected to one another by one or more webs, are produced as one workpiece and connected to the non-magnetic metallic holder and then the web or webs is or are removed and/or cut through.

By galvanizing the stator lamination, the corrosion resistance of the electric motor is increased. Furthermore, a galvanized lamination can be projection-welded to the non-magnetic holder in such a way that individual zinc atoms and individual atoms of the non-magnetic holder form a common structure and, as a result, the stator laminations are permanently connected to the holder without altering the iron structure of the stator laminations. Projection welding also has the advantage that a stable connection with small dimensions is established.

Finally, projection welding has the advantage that the working step requires only a short time and the workpiece produced by the welding can be further processed immediately.

Of course, adhesive bonding or soldering of the stator laminations to the holder is also possible in principle, but the time required for this is greater than the time required for projection welding.

Brass has been found to have particularly good properties for being worked as the non-magnetic metal, with at the same time adequate stability.

The fact that the stator laminations form a stator which centrally forms an opening for receiving the rotor allows a compact electric motor to be constructed. In this type of configuration, a simply constructed distribution of the magnetic force vectors occurring can be achieved by pairs of opposite stator laminations which are respectively bent in such a way

that they can receive a coil.

In its simplest form, such an electric motor has two coils and four stator laminations. An electric motor of this type can be realized in a particularly compact form if two of the opposite stator laminations are in each case cranked once in such a way that one of the coils is arranged between their free ends in such a way that it is magnetically coupled with the stator laminations.

The form of the electric motor described above becomes even more compact if the two other opposite stator laminations have in the vicinity of the opening a first crank and in the vicinity of the free ends a second crank in such a way that the second coil is arranged between their free ends in a manner magnetically coupled with the stator laminations. In particular, a gear mechanism can then be realized in a simple way by a worm drive which can interact with a spur gear being arranged on the shaft of the rotor.

If the holder has a foot for mechanically fixing the stator at the place where the stator is fitted, the stator as a whole can be fastened easily. This fastening becomes particularly easy if the holder can be cranked for fixing, in particular once the foot has been inserted through an opening provided for this purpose in the housing of the electric motor.

The stator can be positioned easily and reliably in the housing or on a base plate through an opening in a stator lamination into which a positioning pin, for example of a housing, protrudes, in particular in combination with the design of the holder last described.

The stator laminations can be separated particularly easily from the web or the webs if they are cut through by punching and/or are removed completely.

The stator laminations can be positioned particularly easily and precisely on the holder through centering openings in the holder and in the workpiece

09363606-093701

comprising the stator laminations and the connecting web or the connecting webs.

*ins 93* The invention is explained in more detail below for a particularly preferred exemplary embodiment on the basis of the figures, in which:

Figure 1 shows a view of a workpiece comprising four stator laminations which have not yet been cranked and are still connected to one another via a web.

Figure 2 shows a view of a holder.

10 Figure 3 shows a view of the holder from figure 2 connected to the workpiece from figure 1.

Figure 4 shows a view of the stator laminations and of the holder from figure 3 after their punching and the cranking of the stator laminations.

15 Figure 5 shows a perspective rear view of the stator laminations and of the holder from figure 4.

Figure 6 shows a perspective view of the stator laminations and of the holder from figure 4 in interaction with a rotor.

20 Figure 7 shows the view and the partial section through an electric motor which has the components from figure 6.

*ins 94* In figure 1, a workpiece W has the stator laminations 1, 2, 3, 4 and a web 5, which connects the stator laminations 1, 2, 3, 4 to one another. The workpiece W is, for example, punched out from galvanized steel plate. The stator laminations 1, 2, 3, 4 have in each case a flattened portion 6 for the easy fitting of coils, described later, arranged between pairs of stator laminations 1, 2 and 3, 4, respectively. In the case of each stator lamination 1, 2, 3, 4, the positions of pairs of weld points 7 for connecting to a holder, to be described later, are represented. The stator lamination 1 has an opening 8 in the form of an elongate hole for receiving a positioning pin, which may be arranged for example in a housing.

A double circle 9, drawn in dashed lines, shows the limiting regions between the web 5 and the stator

09363606-091701

laminations 1, 2, 3, 4. The web 5 also has a round centering opening 10 and four indentations 5a.

In figure 2, a holder 11, which is for example punched from brass plate, has eight round boss-shaped projections 12, two feet 13, four radially bent elongate holes 14, four webs 15, which interrupt the elongate holes 14, and a center piece 16 with a centering opening 17.

In figure 3, the holder 11 is connected to the workpiece W by eight projection welds, which are located between the boss-shaped projections 12 and the positions of the weld points 7 lying thereunder, not visible in figure 3, of the stator laminations 1, 2, 3, 4. Before the welding, the holder 11 and the workpiece W may be centered with one another by a pin, which is passed through the centering opening 17 of the holder 11 and the centering opening 10 lying thereunder of the workpiece W. Depending on the nature of the pin, the diameters of the centering openings 10, 17 have the same dimensions, if the pin is of a cylindrical form, or different dimensions, if the pin is of a tapered form. The centering openings 10, 17 may also be of a polygonal shape.

To obtain the opening 18 represented in figure 4 for receiving the rotor, to be described later, the web 5 has been removed from the workpiece W and the center piece 16 with the webs 15 have been removed from the holder 11. The stator laminations 1, 2, 3, 4 are consequently magnetically separated from one another. The removal of the web 5, the center piece 16 and the webs 15 can be advantageously performed by punching out the parts to be removed, it also being possible for the centering opening 17 to serve as a positioning aid for the tool required for the punching. In figure 4, web stumps 15a of the otherwise removed webs 15 can still be seen. The fact that, in the case of the holder 11, only the webs 15 have to be cut through and not the entire circumference of the opening 18, means that the holder 11 and the welds on the stator laminations 1, 2,

0986806-094701

3, 4 are subjected to less loading by this punching operation and the holder 11 is not deformed. In figure 4, the stator laminations 1, 2, 3, 4 have also already been bent into their final position.

5           The perspective view in figure 5 shows the rear view of the stator laminations 1, 2, 3, 4 represented in figure 4, with the holder 11. It can be seen that the ends of the stator laminations 1, 2, arranged on the holder 11, and of the stator laminations 3, 4  
10           respectively lie opposite one another and that the stator laminations 1, 2 are each cranked once and the stator laminations 3, 4 are each cranked twice in such a way that a coil (not represented) can be arranged in each case between the stator laminations 1, 2 and 3, 4,  
15           respectively, with the flattened portions 6 of the stator laminations 1, 2, 3, 4 facilitating fitting.

          In the case of the perspective view in figure 6, in the opening 18 there can be additionally seen a diametrically magnetized rotor 19, which is rotatably  
20           mounted by means of a rotor shaft in two bearings, of which the bearing 21 is represented. On the rotor shaft 20, a worm drive 22 is securely connected to the rotor.

          In the case of the perspective view with a  
25           partial section of an exemplary embodiment of a complete electric motor according to the invention, the position of the view of the stator laminations 1, 2, 3, 4 and of the holder 11 approximately coincides with the position of the view of these parts in figure 5. A  
30           coil 23 is arranged between the ends of the stator lamination 2 and the stator lamination 1, which cannot be seen, and is magnetically coupled to them. Similarly, a coil 24 is arranged between the ends of the stator laminations 4, 3, the view of the end of the  
35           stator lamination 3 being concealed in figure 7 by a lower housing part 25. The motor can be operated as a stepping motor, for example by activating the coils 23, 24 with current pulses, or as a synchronous motor, by activating the coils 23, 24 with sinusoidal currents

099606-091704

offset by 90°.

The worm drive 22 is in effective connection with a spur gear 26, which is rotatably mounted by means of a shaft 27. A further part of a gear mechanism for example can be fitted onto the shaft 27. It is also possible to fit an indicator onto the shaft 27 and in this way realize a measuring mechanism, in particular when the motor is activated as a stepping motor. The stepping down of the rotary steps of the motor by the gear mechanism comprising the worm drive 22 and the spur gear 26 additionally allows the resolution to be increased. The prescribed motor can be protected against environmental influences by an upper housing part 28, which is advantageously able to be fastened on the lower housing part 25 by means of a clip 29. Finally, the electric motor described above can be fastened easily, quickly and permanently on a printed circuit board, not represented, for example by means of an engaging element 30.

0986806-091701